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RECEIVER SYSTEM CONTROL DEVELOPMENT FOR THE AFGL HIGH LATITUDE METEOR SCATTER TEST BED IN GREENLAND

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GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
HANSCOM AIR FORCE BASE, MASSACHUSETTS 01731-5000

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"This technical report has been reviewed and is approved for publication".

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FOR THE COMMANDER

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Division Director

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This document describes the new Geophysics Laboratory (GL) meteor scatter receiving system installed in the GL High Latitude Meteor Scatter Test Bed. The hardware and software aspects of the receiving system are discussed. The field-site installation is described and future system control software are recommended.

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1.0 INTRODUCTION

The Geophysics Laboratory (GL) High Latitude Meteor Scatter Test Bed is a VHF meteor scatter link between Sondrestrom Air Base and Thule Air Base, Greenland. In the past the receiving system at Thule consisted of a logarithmic receiver, a Hewlett Packard HP-85 system controller, Analogic D-6000 signal analyzer, and a Kennedy 6455 tape recorder. This receiving system was susceptible to EMI from other components. The system also required complicated calibration procedures due to the non-linear nature of the logarithmic detector and was limited to receive only four frequencies. Furthermore, system dead time between consecutive data acquisition periods made it difficult to identify meteor trails longer than four seconds.

In November 1987 a new receiving system was successfully installed and tested. The new system incorporates an IBM-AT type system controller and a synchronous receiver to tackle the problems mentioned above. Moreover, the system provides battery power backup, automatic system restart after power failure and remote system status polling capability to improve reliability and simplify routine maintenance.

This test report addresses both the hardware and software aspects of the new receiving system and baselines the system for future reference. However, readers should refer to [1] for hardware details (especially the synchronous receiver). The system software architecture and individual software modules are discussed here. The field-site installation is described and some data from the new receiver system are presented. Finally, future system control software developments are recommended.

2.0 RECEIVER SYSTEM HARDWARE DESCRIPTION

The new receiving system consists of a Zenith Z-248 (IBM-AT compatible) microcomputer, a synchronous receiver, an on-line printer, a Best 500 VA uninterruptible power supply (UPS), a Kennedy tape backup unit and a 2400 baud dial-up modem. The system block diagram is depicted in Figure 1. Inside the Z-248 computer, a MetraByte Dash-16 data acquisition board digitizes the phase-locked signals supplied by the synchronous receiver. The receiver provides in-phase and quadrature data at six frequencies (35, 45, 65, 85, 104 and 147 MHz) with corresponding horizontally and vertically polarized antennas. The six frequencies are transmitted with a 400 Hz FM identification signal. When the 400 Hz FM tone is detected by the receiver, the data samples are stored on the 1/4 inch cartridge tape. An IBM graphic printer displays on-line system status for diagnostic purpose and a Zenith 2400 baud modem provides outside telephone dial-up link for remote status polling. Finally, a Best UPS smooths out frequent local power fluctuations and allows orderly system shutdown and restart following a power failure. Some of the system components in Figure 1 are discussed in the following paragraphs.

2.1 The Zenith Z-248 Computer

The Zenith computer serves as the system controller interfacing to various input/output peripherals. The computer contains 640 K byte of core memory, 2 M byte extended memory, two serial ports, one parallel port, 20 M byte hard disk, 360 k byte floppy drive and graphic display unit. The open architecture of the computer allows numerous hardware and software expansion options as compared to the HP-85 controller. An internal calendar clock with

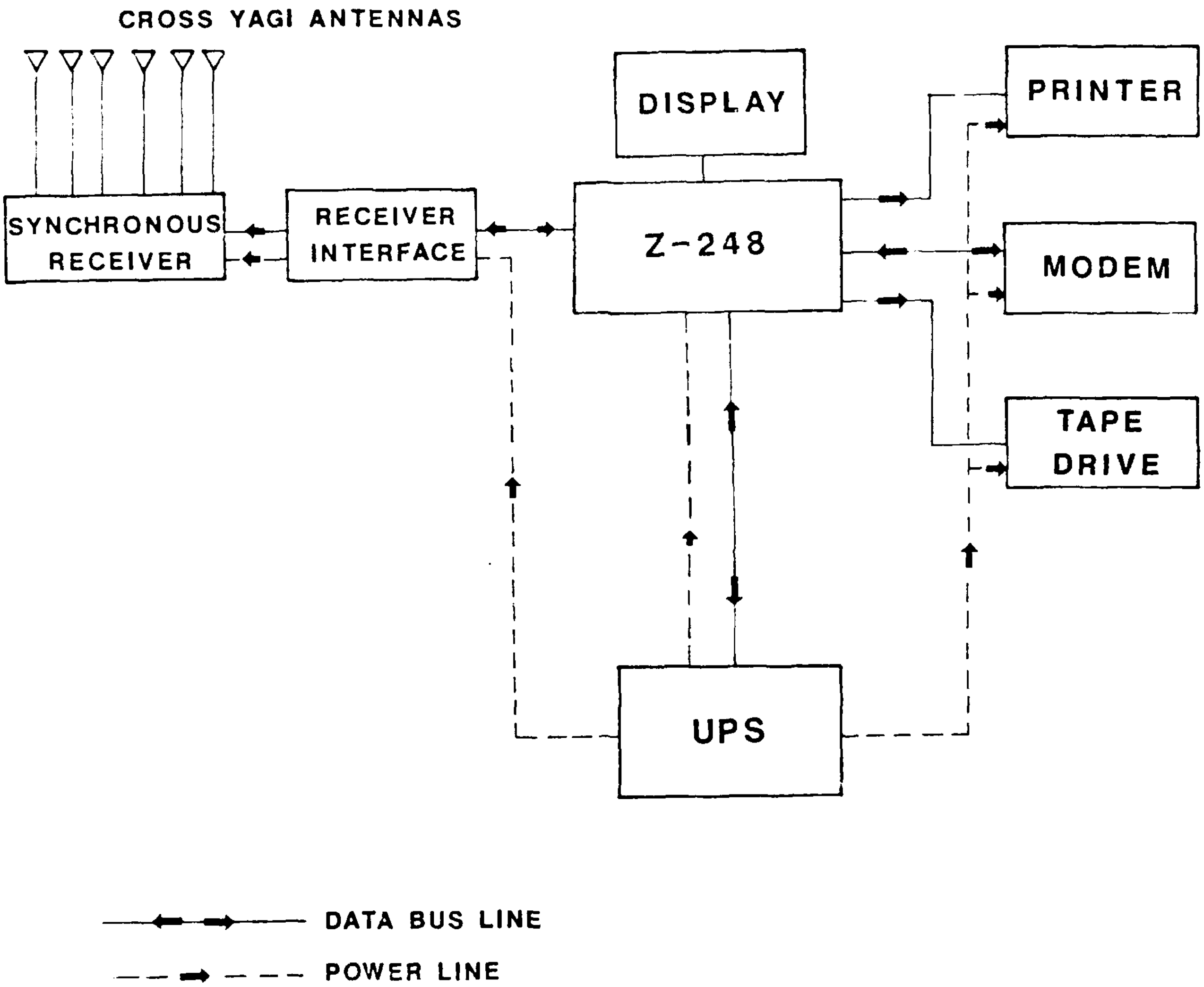


Figure 1. Receiver System Hardware Block Diagram

battery backup provides adequate synchronization with the transmitter without a satellite clock or expensive timing standards. The graphic interface provides real-time displays of receiver output and various system status information. Serial communications between the computer, the UPS and the dial-up modem are achieved through the two RS-232 ports. The remaining parallel port drive the on-line printer.

2.2 The Synchronous Receiver

The synchronous receiver is inherently linear and avoids the non-linear characteristics and instability problems of the logarithmic receiver. Internal calibration sources eliminate the use of an external signal synthesizer and further simplifies the receiver calibration procedures. The new receiver system is capable of receiving at the six frequencies, 35, 45, 65, 85, 104 and 147 MHz. In-phase and quadrature signals from both the horizontal and vertical polarized antennas are generated simultaneously in the receiver. The horizontal and vertical antennas enable polarization measurements to be made that were not possible with the old receiver system. The receiver is mounted on the antenna tower to minimize cable loss and interference pickup. Heating resistors and insulating material allows the receiver to maintain a stable ambient temperature under the harsh Arctic environment. The receiver is powered by the receiver interface placed near the Z-248 computer. The receiver interface also provides buffers for control signals and noise suppressing filters for the receiving signals.

2.3 The MetraByte Dash-16 Data Acquisition Board

The data acquisition board consists of a 12-bit analog-to-digital (A/D) converter, two digital-to-analog (D/A) converters, 4-bit digital output port and a 4-bit digital input port. The board is set up to have eight bipolar channels for A/D data conversion, though only five channels are actually being used. The five channels are the in-phase and quadrature channels of the vertical and horizontal antennas and the FM detector locked flag. Every 10 ms, the five channels are samples with 40 μs separating each channel. The data samples are transferred to the computer in a high speed direct memory access mode. The D/A converters are reserved for an analog chart recorder to monitor the stability of the receiver. The 4-bit digital output port selects the different receiving frequencies to be sampled and activates the receiver's internal calibration.

2.4 The Kennedy Tape Drive

The Kennedy 6455 tape drive stores data in 4-track serpentine format. Tapes with 10 M (DC-300) and 20 M (DC-600) capacity are available. The Kennedy tape drives have proven reliable in this application. A Pertec interface allows high speed data transfer between the tape drive and the Z-248 computer.

The software driver supplied by the manufacturer allows simple block to block data transfer. The noise, calibration and trails records are stored sequentially and the receiver program MBRECR informs the user of the remaining percentage of tape available, and the track lights on the front panel of the tape drive also indicate the amount of tape used.

2.5 The Best Uninterruptible Power Supply

The UPS with 500 VA rating backs up the entire receive system and suppresses local AC power line fluctuations. The battery of the UPS supplies more than 30 minutes of backup power to avoid most of the short term outages. In addition, the UPS continuously reports the current AC line status and available backup time to the Z-248 computer allowing orderly shutdown of the receiving system.

3.0 RECEIVER SYSTEM SOFTWARE DESCRIPTION

The new receiving system acquires data samples continuously at 100 Hz in a background DMA mode. Once 500 samples (in a 5 second period) are gathered, the data are analyzed and displayed in real-time on the monitor of the Z-248. If the 400 Hz FM tone is detected, this record of 500 samples is stored. Meanwhile, the system services the UPS and the dial-up model through two asynchronous serial ports. System status is constantly recorded on a printer. Hence within 5 seconds, the Z-248 has to finish processing 500 samples and service various peripherals before the next 500 samples are acquired. To sustain this continuous operation, a multi-tasking approach was chosen. The data acquisition and processing software module (MBRECR) is running continuously in the foreground while several peripheral handling modules (MBPRINT, MBUPS, MBROUTE) interrupt periodically in the background. Every 3 ms, the background modules are executed according to their assigned priorities. The overall system software architecture is depicted in Figure 2. The software modules are described in the following subsections and their corresponding flowcharts are shown from Figure 3 to Figure 11.

3.1 MBEXEC (Figure 3)

MBEXEC (Figure 3) is a multi-tasking schedule that provides for execution of each background module. Each module is assigned a priority and frequency of execution. The MBEXEC schedule executes appropriate modules in the correct order and frequency. The foreground module (MBRECR) is interrupted temporarily until all background modules are serviced by the MBEXEC module. Usually all background modules will finish

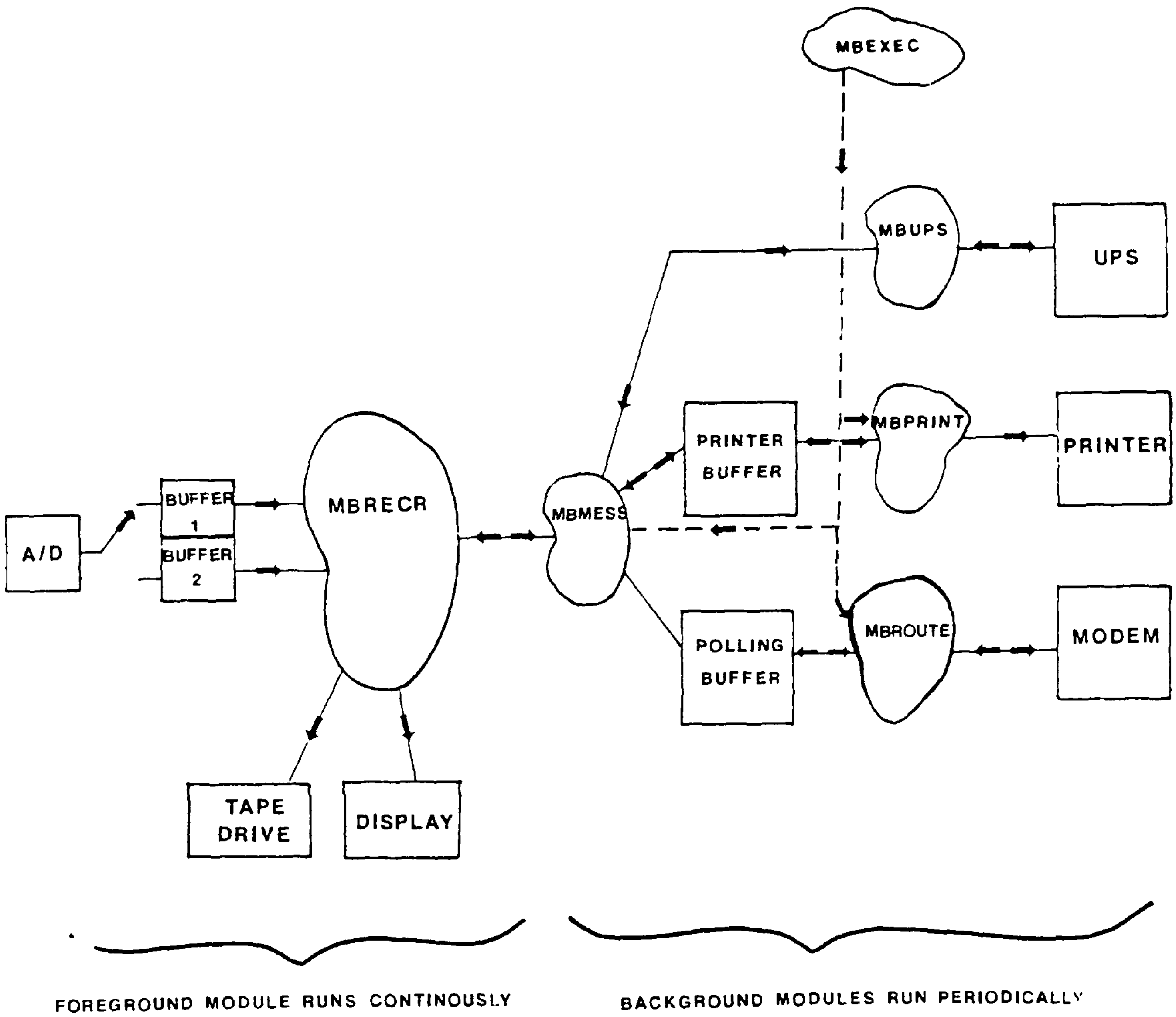


Figure 2. Receiver System Software Block Diagram

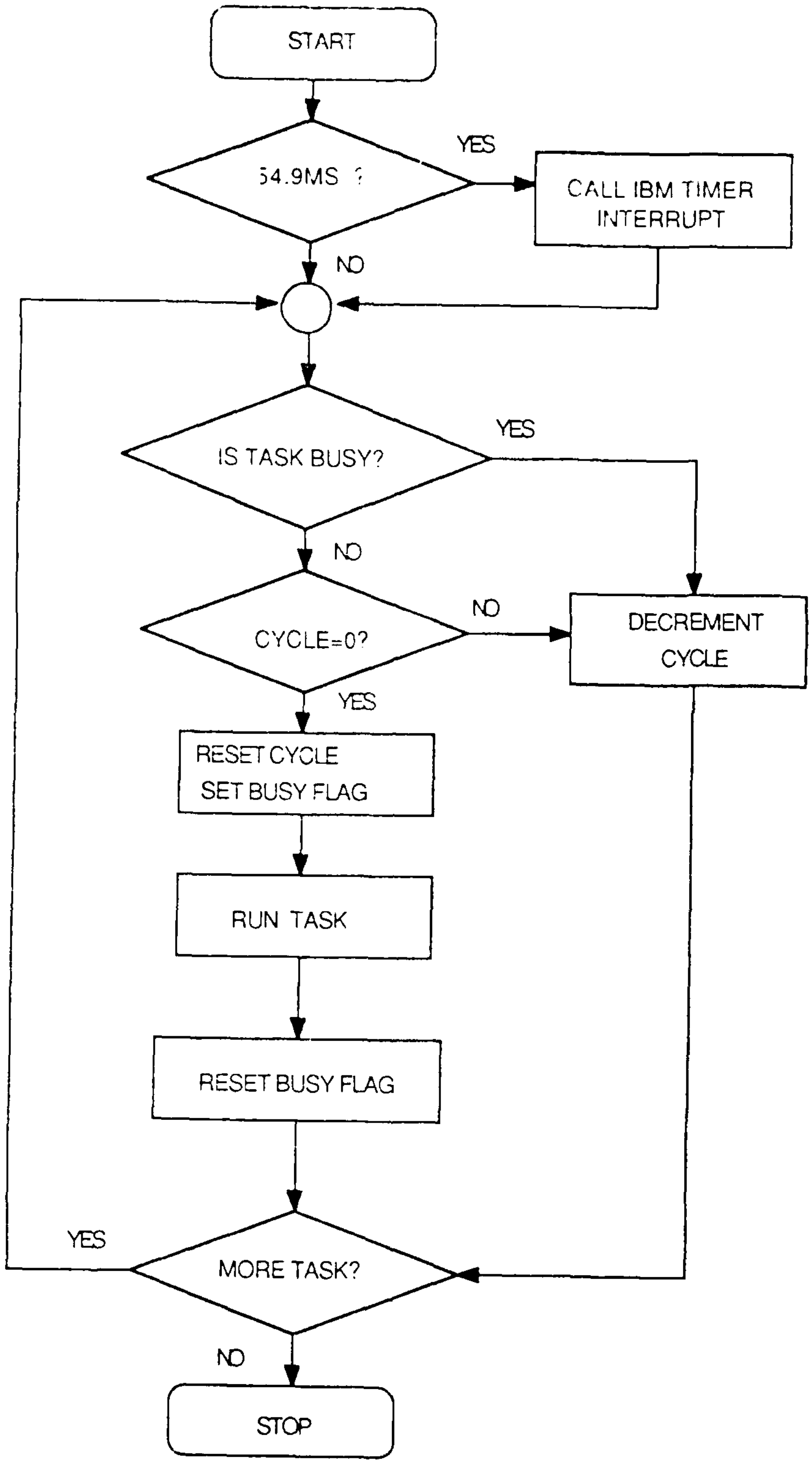


Figure 3. Program Flow-Chart of MBEXEC

execution well within 3 ms. The MBEXEC is set up to allow insertion and deletion of a background task in the multi-tasking job queue.

As compared to an interrupt-driven structure, this multi-tasking scheme provides a better debugging environment and simplifies insertion of additional background modules.

3.2 MBPRINT (Figure 4)

MBPRINT (Figure 4) supports both serial and parallel printers with non-waiting input/output capability. Furthermore, the module detects printer failure and avoids the resulting hangup of the Z-248 computer. Once a printer resumes operation, the module continues outputting data to the printer.

3.3 MBUPS (Figure 5)

This module (Figure 5) monitors the UPS message for any power failure condition. It alerts the MBRECR data acquisition module to proceed with the orderly shutdown of the system, if necessary. Once the power is reestablished, MBUPS cancels the alarm sent to the MBRECR module.

3.4 MBROUTE (Figure 6)

The MBROUTE module (Figure 6) services the RS-232 serial port for remote polling. It supports different baud rates from 110 to 2400 baud. A polling command handle inside the module executes the remote system status polling commands. Presently, a user can only inquire about the receive frequency and the available tape storage.

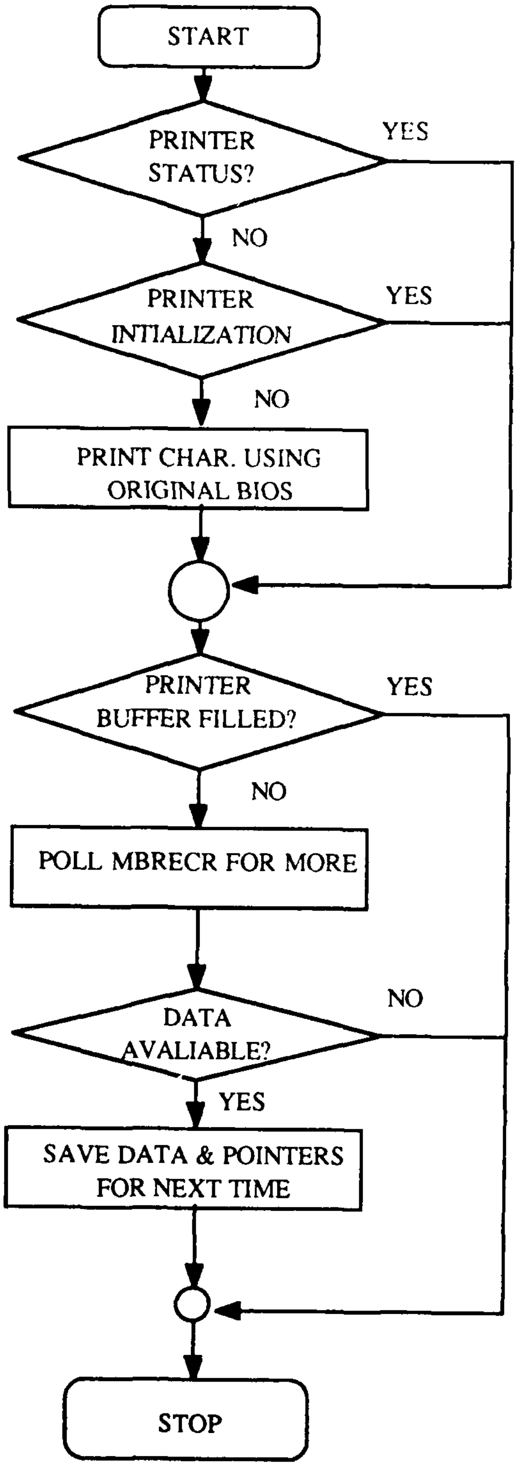


Figure 4. Program Flow-Chart of MBPRINT

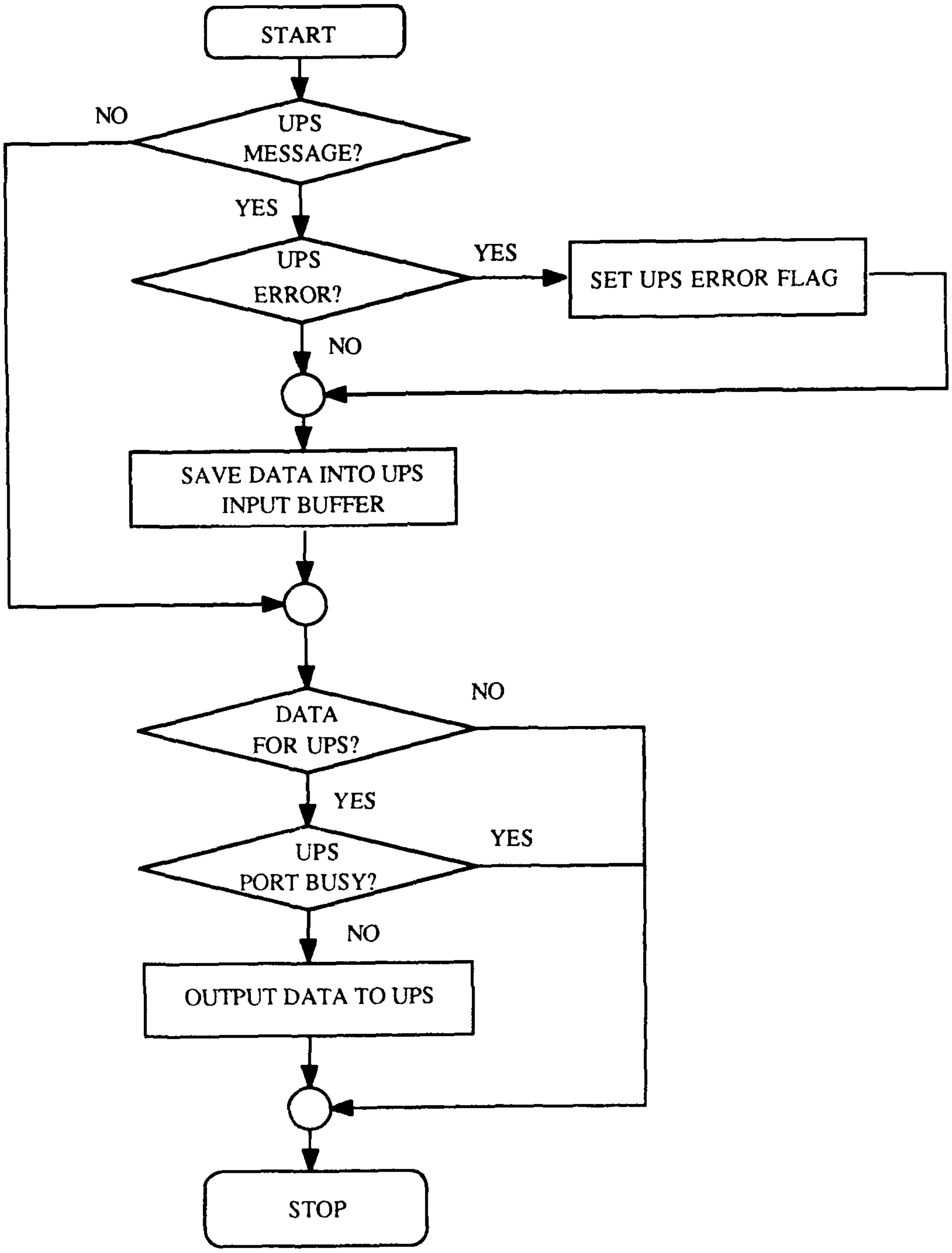


Figure 5. Program Flow-Chart of MBUPS

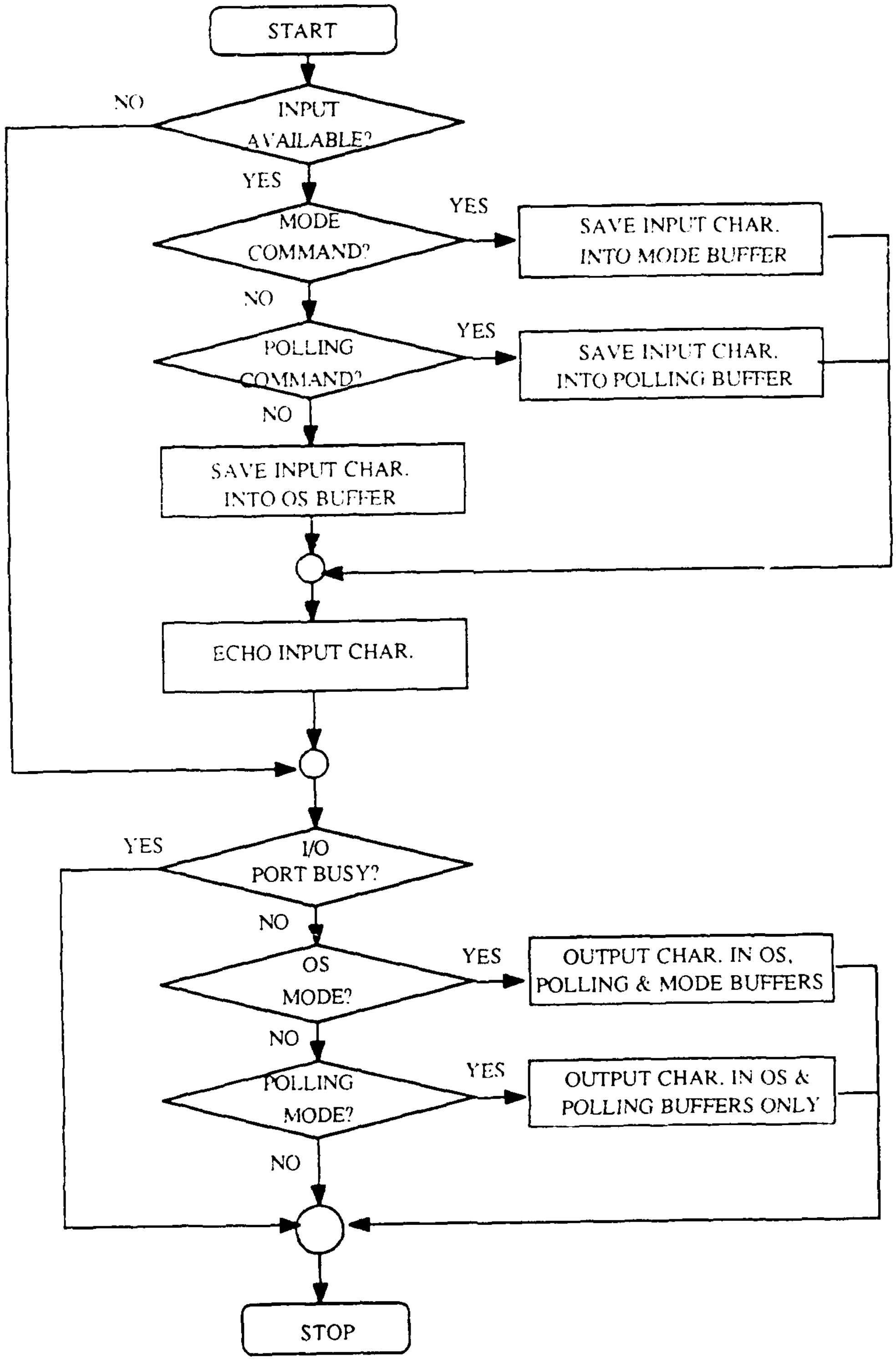


Figure 6. Program Flow-Chart of MBROUTE

3.5 MBMESS (Figure 7)

This module (Figure 7), coded in Assembly programming language, interfaces between the foreground MBRECR module and various background modules. It consists of input/output buffers and interrupt handles for each of the peripheral supporting modules. It monitors the system status in the foreground MBRECR module and issues the information to various background modules when polled. It isolates the foreground and the background modules to allow independent software development. Moreover, the module provides data routing among the background modules.

3.6 MBRECR (Figures 8, 9, 10, 11)

This foreground data acquisition module (Figures 8, 9, 10, 11) evolves from a stand-along prototype program developed by Jens Ostergaard [1]. The module was written in Turbo Pascal to take advantage of modern structural programming language. The availability of Turbo Pascal drivers for the Dash-16 A/D board reduced the software development effort. However, the C programming language is preferable if a major rewrite is considered; the C language is more suitable for mixed language programming. The prototype program was modified to allow zero dead-time between adjacent records of 500 data samples. Pointers to the system status were passed to the MBMESS module to distribute current system information.

The three main functions of MBRECR are noise measurement, receiver calibration and meteor trail acquisition. The module reads a schedule file to select proper receiver functions and receiving frequency. The calibration routine determines the DC offsets and the receiver gains among the four channels (the in-phase and quadrature channels of both the horizontal and vertical

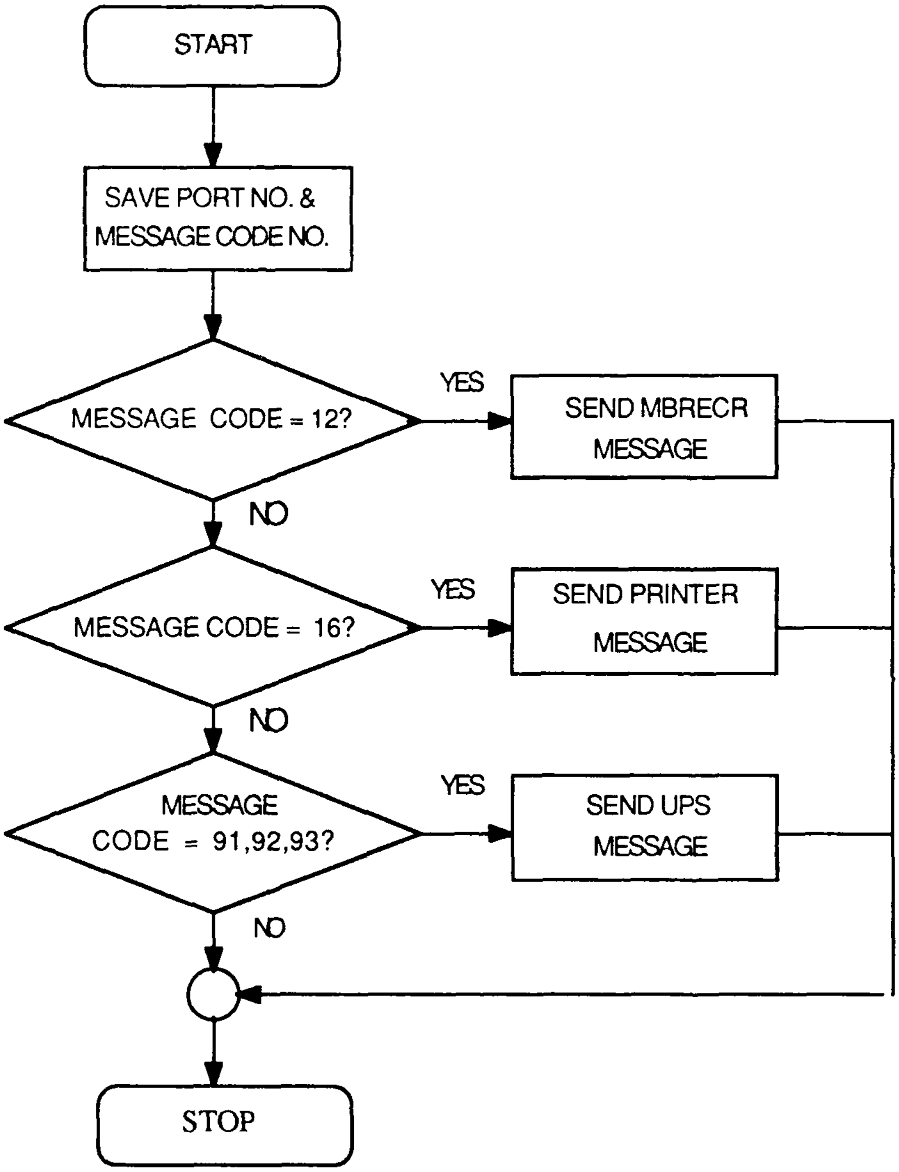


Figure 7. Program Flow-Chart of MBMESS

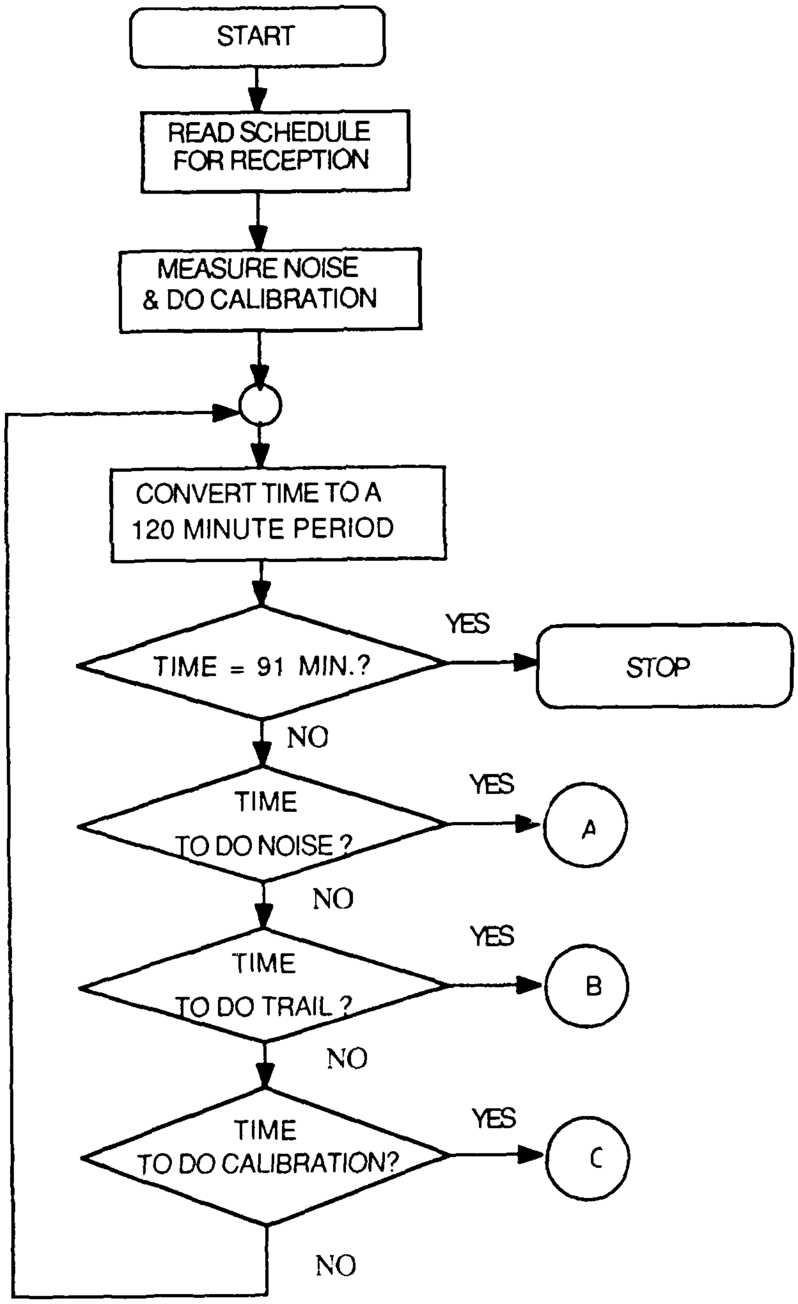


Figure 8. Program Flow-Chart of MBRECR

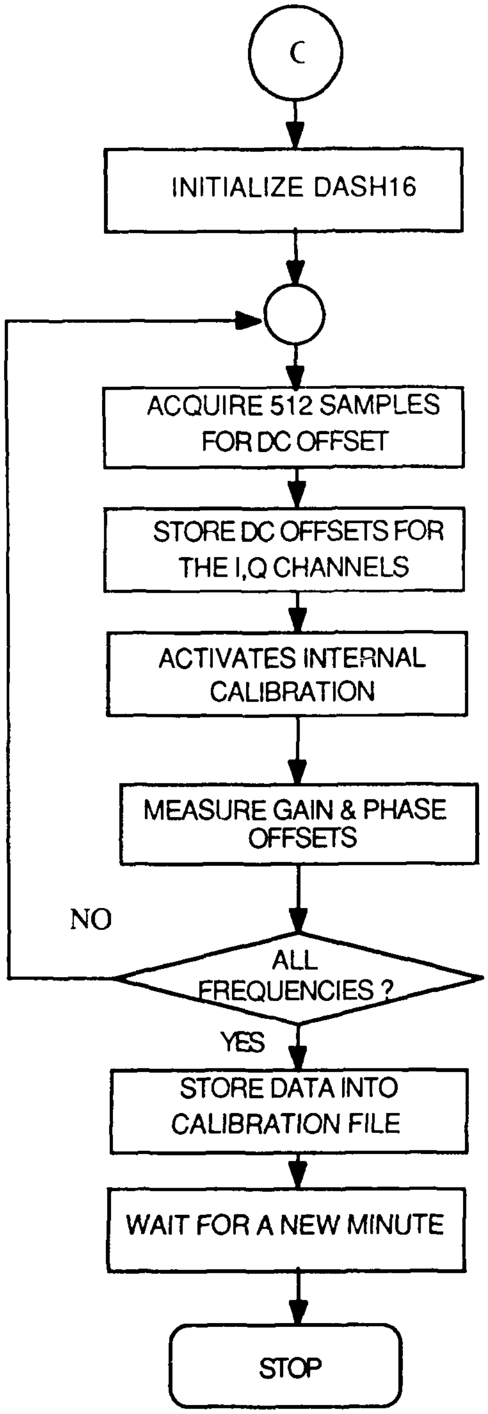


Figure 9. Program Flow-Chart of the Calibration Routine of MBRECR

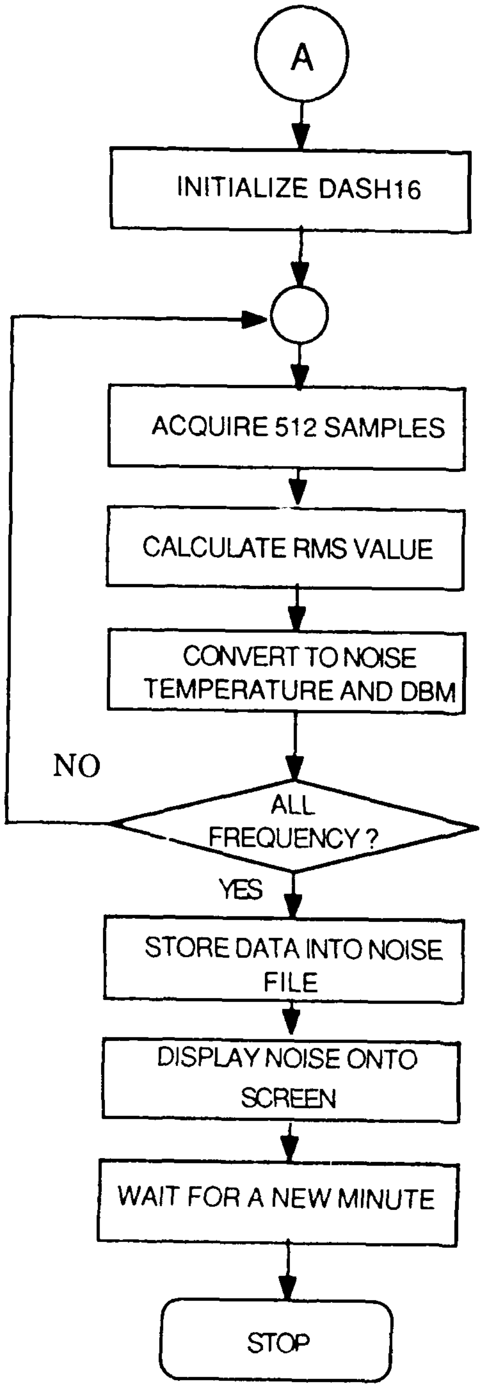


Figure 10. Program Flow-Chart of Noise Routine in MBRECR

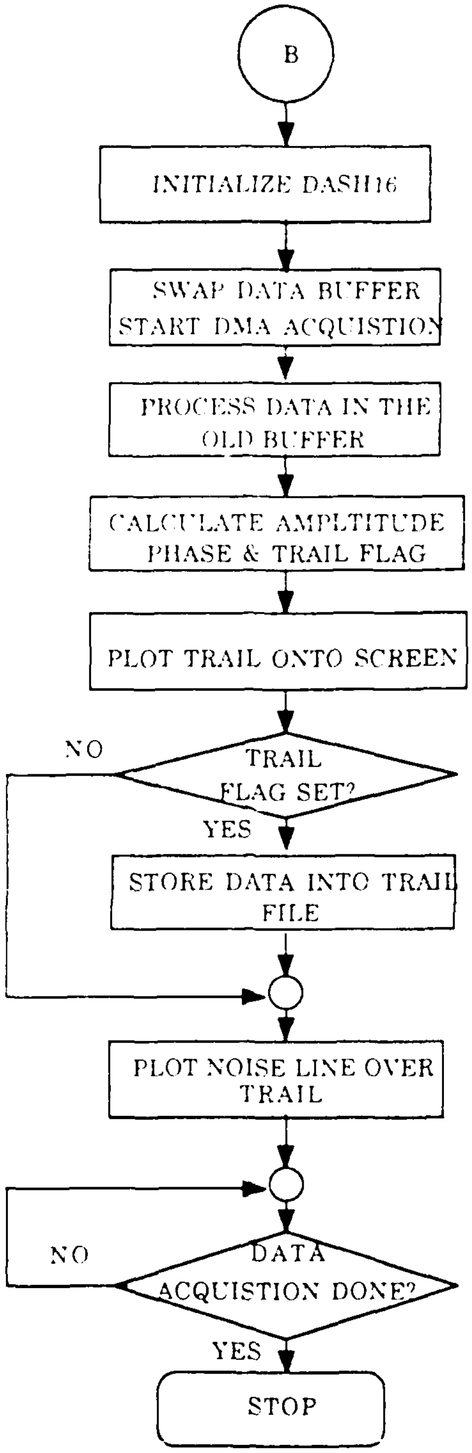


Figure 11. Program Flow-Chart of Trail Routine of MBRECR

antennas). The phase difference between the horizontal and the vertical antenna channels is also evaluated. The noise measurement routine calculates the raw noise power for each of the six receiving frequencies. The meteor trail acquisition routine displays the receiver outputs every five seconds and records the data from both the vertically and horizontally polarized antennas if the FM detection flag is set. The binary values of the FM detection lock flag during the five second period are also recorded.

The MBRECR module cycles through the six receiving frequencies with noise measurements and a calibration interspersed in a two-hour period.

The reception sequence is read from a schedule file (Appendix A) during system initialization. The schedule file contains the starting time, the ending time, and the receiving frequency for each measurement. Moreover, the file stores the station header, the channel gains and the phase offset of the receiver. Hence, the schedule file has to be updated once a new receiver is installed.

The noise measurement and the calibration data are saved in floating-point format while the meteor trails are stored as two-byte integers. Both data records use a common 30-byte header to describe the data type, the time of reception and the station identification. The data format of the noise, calibration and trail records are described in Appendix B. All the data records are stored instantaneously into 1/4 inch cartridge tapes. The binary data are packed to reduce the frequency of tape changes. Presently, a 20 Mbyte (DC-600) tape lasts for two to four days on the average. Additionally the noise and calibration records are accumulated in a daily noise file in the hard disk of the Z-268 computer.

3.7 TESTRECR

A diagnostic (TESTRECR) program has been developed to provide basic testing procedures for the receiver. The procedures allow noise measurement, calibration, meteor trail acquisition and monitoring of receiver output voltages.

The noise measurement routine shows the current noise temperatures of the horizontal and vertical channels at each of the six frequencies. Moreover, the current temperature of the receiver box is displayed.

The calibration routine is similar to that of the regular receiver program in measuring DC offsets and gains for all channels. The internal calibration source is enabled to provide a constant signal to calculate the receiver gain on both horizontal channels.

The meteor trail acquisition routine plots the horizontal and vertical channel outputs at a user-selected frequency continuously. Every five seconds, the two plots are updated to show the instantaneous receiver outputs. Moreover, the FM detection flag is displayed in between the plots to indicate the reception of a meteor trail.

The channel voltage monitoring routine displays the voltage levels of the eight channels in the Dash-16 digitizer card. The eight channels are the in-phase and quadrature samples of the horizontal channel, the in-phase and quadrature samples of the vertical channel, the FM lock flag, the 400 Hz FM detector output, the receiver temperature sensor, and a spare channel respectively.

User can select any of the four testing procedures. However, the calibration routine must be selected once to provide current DC offsets on all eight channels before any noise measurement and meteor trail acquisition can be performed. Then, any of the four procedures could be activated in any order.

The noise measurement and the calibration routines are essential in monitoring the stability of the receiver. The internal calibration results should be constant to within 1 or 2 dB while the noise temperatures should demonstrate the diurnal changes of the Galactic noise.

3.8 BASCAL

The calibration of the receiver is relatively straightforward due to the linear nature of a synchronous receiver. A one point calibration is only required to calibrate the receiver. A signal synthesizer with a two-way power splitter can be used to generate the necessary in-phase signals for the horizontal and vertical channels.

The calibration software (BASCAL) determines the DC offsets of all eight channels before the signal synthesizer is turned on. Then the user is prompted to input a -100 dBm signal from the signal synthesizer. From the outputs of the horizontal and the vertical channels, the signal gains of the two channels are calculated. Additionally, the phase offset between the two channels are determined. These calibration results are stored in the schedule file (SCHEDULE.TXT) which the MBRECR module will read during initialization. Finally, the internal calibration source is activated to measure another set of receiver gains and phase offset. However, this set of data is not absolute and the results are used to monitor the stability of the receiver only.

4.0 FIELD-SITE TESTING

In November 1987, the new receiving system was installed and tested successfully at Thule Air Base in Greenland. The UPS was found to be extremely useful in suppressing power line interference and providing backup power. Eventually, the logarithmic receiver of the old receiving system was also connected to the UPS to reduce EMI pickup. The old system was kept operating temporarily to compare with the new system. Six horizontal and vertical polarized Yagi antennas at 35, 45, 65, 85, 104 and 147 MHz were set up. Successful reception was demonstrated at the available transmitting frequencies of 45, 65, 104 and 147 MHz. Appropriate noise and calibration results were also obtained. However, inadequate isolation between the horizontal and vertical antennas was observed and requires further investigation.

A telephone dial-up link was established between the main site and the remote site a mile away. A hookup between the main site at Thule and a remote terminal at Hanscom Air Force Base was demonstrated successfully. The remote terminal is used to monitor the receiving system status and allows system reset remotely.

In March 1988, the Kennedy 6455 tape drive successfully replaced the error-prone InterDyne tape drive. The Kennedy has a more rugged design and utilizes a read-after-write scheme to assure the integrity of the recorded data. The data records are stored sequentially in a binary format to minimize the tape usage.

Furthermore, a new balanced feed scheme was implemented to improve the isolation of the horizontally and vertically polarized antennas. All six crossed Yagi antennas were re-tuned and the receiver was programmed to receive at all six frequencies. The reception is successfully with the exception of too much noise interference at the 35 MHz frequency. The noise was traced to the switching power supply inside the receiver. This problem was solved once a new receiver, equipped with additional noise filters, was installed in July 1988.

Since March 1988, the receiver system has been operating continuously and gathering meteor scatter data reliably.

An example of the data from the new system is shown in Figure 12. The horizontal and the vertical antenna signals with the FM lock flag in the middle were displayed.

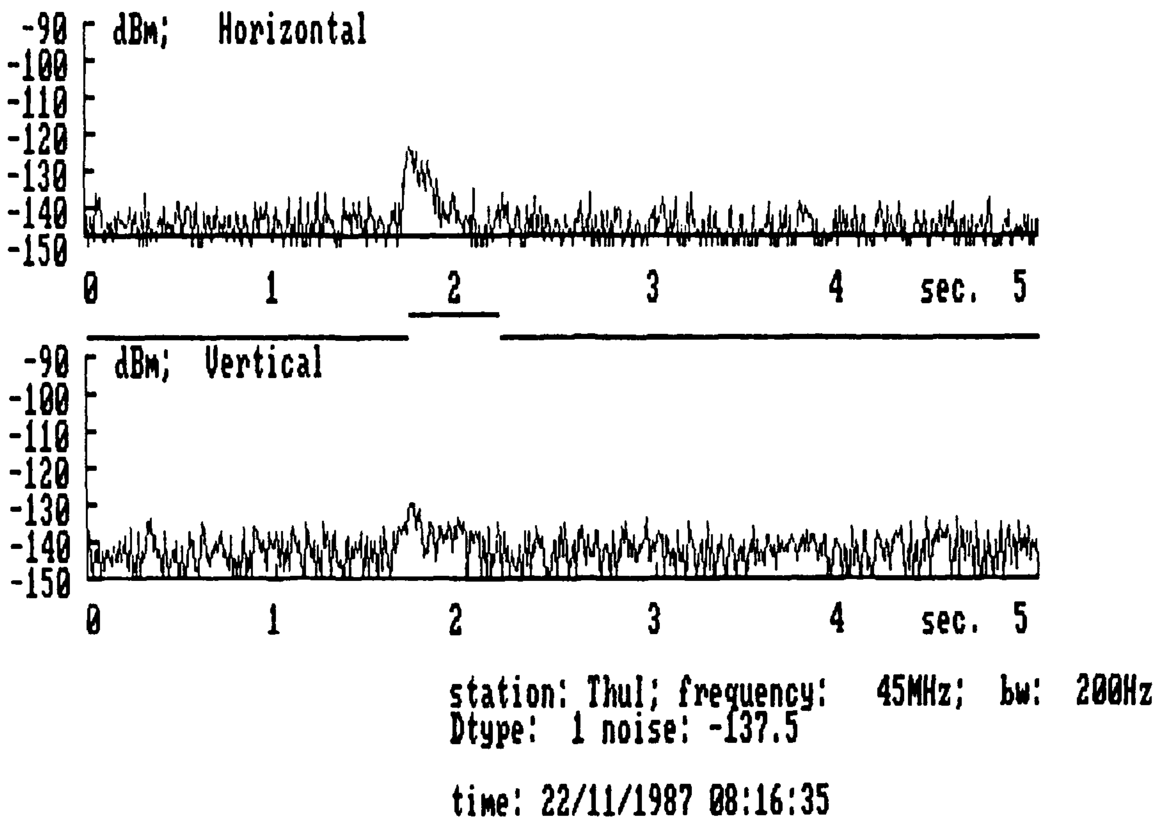


Figure 12. Meteor Scatter Data from Thule, Greenland

5.0 CONCLUSIONS AND RECOMMENDATIONS

The receiver system is pretty stable after the installation of the Kennedy tape drive.

The meteor scatter receiver system has been operating in six frequencies since March 1988. The installation of the Kennedy tape drive improves the reliability of the medium. With the increasing presence of sporadic-E reflection in the summer, the data has to be packed to reduce the tape usage. The adoption of 20 M byte tape (DC-600) further reduces the tape demand. Moreover, the Kennedy tape drive provides automatic tape reload after power failure for fully unattended automatic operation. However, additional software development is required to avoid overwriting existing data on the tape. The next software development will be on incorporating a satellite clock into the system. Currently, the receiver system timing is provided by a battery backup clock inside the Z-248 computer. However, the battery clock does not have enough accuracy to maintain continuous synchronization between the receiver at Thule and the transmitter at Sondrestrom, Greenland. The addition of a satellite clock with a HP-IB bus will allow the Z-248 computer to have an accurate time reference.

6.0 REFERENCES

1. Jens Ostergaard, "Preliminary Investigation of Faraday Rotation Effects," Rept. GL-TR-89-0123, Geophysics Laboratory, Hanscom Air Force Base, January 1989. ADA211289

APPENDIX A

METEOR SCATTER DATA FORMAT

METEOR SCATTER DATA FORMAT

The Meteor Burst data consists of three different types of data records. Within each record there is a 30-byte header and either 144 or 1500 bytes of binary data for a noise, calibration or trail record. The formats of the three records are described as follows:

1) Noise Record (174 bytes length)

Header: 30 bytes

time - year, month, day, hour, minute, second
yyyymmddhhmmss (14-byte ASCII string)
dtype - data type (2-byte integer)
station - station ID (6-byte ASCII string)
checksum - record checksum
frq - receiver temperature in degree Celsius
bw - bandwidth in HZ (2-byte integer)
noise - noise temperature in dBm

Data: 144 bytes

freq 0 to freq 5 noise - raw noise in V rms
noise temp. in deg. K
noise power in dBm
(all data are in 8-byte 8087 real format)

2) Calibration Record (174 bytes long)

Header: 30 bytes (same as the noise record)

Data: 144 bytes
freq 0 to freq 5 calibration - Hor. gain in dBm
Ver. gain in dBm
Phase corr. in deg.
(all data are in 8-byte 8087 real format)

3) Trail Record (1530 bytes length)

Header: 30 bytes (same as the noise record except the frq entry contains the receiving frequency in MHz)

Data: 1500 bytes

500-point time sequence of -

a) amplitude of horizontal antenna power in 1/4 dBm step with offset of 90 dBm (1-byte binary).

b) amplitude of vertical antenna power in 1/4 dBm step with offset of 90 dBm (1-byte binary).

c) phase difference in 3 degree units between horizontal and vertical antenna signals. The 8th bit represents the FM lock flag (1-byte binary).

APPENDIX B

INITIALIZATION FILE (SCHEDULE.TXT) LISTING

INITIALIZATION FILE (SCHEDULE.TXT) LISTING

!SCHEDULE.TXT
!The file contains calibration parameters and operational schedule for
!a EC7221 meteor scatter receiver.
!The calibration parameters are unique for a particular receiver. All
!lines beginning with a ! are skipped when the file is loaded into the
!receiver program. The file is an ASCII text file, which can be edited
!with ordinary text editors. The content can also be modified, but not
!expanded with the editor built into the receiver control program.
!
!
!Data in this file:
!Location: Thule,
!Receiver serial no. 5.
!calibration entered 7/25 1988 by EL at Thule
!schedule entered 7/25 1988 by EL at Thule
!Entries 1 through 20 contain station identified and calibration constants

1	Thule	station identifier
2	-136.5	35 MHz Horizontal gain
3	-132.8	35 MHz Vertical gain
4	+055.2	35 MHz phase offset
5	-139.1	45 MHz Horizontal gain
6	-132.0	45 MHz Vertical gain
7	+114.4	45 MHz phase offset
8	-138.2	65 MHz Horizontal gain
9	-134.2	65 MHz Vertical gain
10	+085.5	65 MHz phase offset
11	-138.3	85 MHz Horizontal gain
12	-134.9	85 MHz Vertical gain
13	+340.7	85 MHz phase offset
14	-137.9	104 MHz Horizontal gain
15	-130.8	104 MHz Vertical gain
16	+056.5	104 MHz phase offset
17	-135.0	147 MHz Horizontal gain
18	-130.7	147 MHz Vertical gain
19	+110.0	147 MHz phase offset

```
20
!
!Entries 21 through 40 contain schedule information.  A maximum of
!20 schedule entries can be handled by the receiver.
!Each entry consists of four parameters:
!start time, stop time, within a cycle of 120 minutes,
!task as trail, noise, or calibration (calib); and frequency as 035, 045,
!065, 085, 104, 147 MHz
!         start   stop    task    frequency
!
21        000     000     noise
22        001     010     trail      045
23        011     011     noise
24        012     026     trail      085
25        027     027     noise
26        028     040     trail      035
27        041     041     noise
28        042     061     trail      104
29        062     062     noise
30        063     077     trail      065
31        078     078     noise
32        079     098     trail      147
33        099     099     calib
34        101     101     noise
35
36
37
38
39
40        dc600           type of tape
!End of schedule.txt
```

APPENDIX C

OPERATING INSTRUCTIONS FOR THE AFGL METEOR SCATTER RECEIVERS AT THULE AIR BASE, GREENLAND

OPERATING INSTRUCTIONS FOR THE AFGL METEOR SCATTER RECEIVERS AT THULE AIR BASE, GREENLAND

This note contains instructions for the operation of the AFGL meteor receiver installation in building 1910 at Thule AB. The instruction provides the reference for the daily maintenance work performed by the GC personnel.

1. BACKGROUND

The AFGL High Latitude Meteor Scatter Test Bed operates between Sondrestrom AB and Thule AB, Greenland. The transmitter is placed at Sondrestrom AB, and the receiver is placed at Thule AB. The aim of the measurements is to produce statistics of meteor scatter radio propagation on the frequencies 35, 45, 65, 85, 104, and 147 MHz.

Statistics covering both normal, undisturbed conditions and disturbed conditions during polar radio disturbances must be measured. The time of occurrence of the disturbed conditions are not known in advance, and the generation of valid statistics require continuous data. It is therefore important for us that we do not lose data and the systems are kept running continuously. We greatly appreciate your work to keep the systems running.

Two different, and completely separate receiving systems are operated at Thule AB. One system - the old - measures the signal strength of the signals received from Sondrestrom at 45, 65, and 104 MHz. The other system - the new - measures the signal strength and polarization of the signals received from Sondrestrom at 35, 45, 65, 85, 104, and 147 MHz.

The old system consists of the horizontal Yagi antennas on the tower, the receiver and chart recorder in the rack placed next to the telephone table in the small building, and the equipment contained in the GREEN rack in the small building.

The new system consists of the crossed Yagi antennas on the tower, the receiver mounted on the stair railing on the tower, and the equipment in one of the GREY racks in the small building. The other GREY rack contains a spare computer for the new system. The spare is intended to be used if the primary system breaks down.

A remote telephone terminal placed in building 1971 is connected to the new system. Three messages which show the current status of operation for the new system can be displayed on the terminal. The terminal is intended to help keep the system in operation by providing the GC personnel with easy access to the system status.

2. REQUIRED DAILY MAINTENANCE

One visit to the small receiver building SIX days a week is required. The visit should be performed at a time when the transmitter at Sondrestrom AB is active. This can be any time, except the last half hour before each even hour (0730 - 0800 UT, 0930 - 1000 UT, etc.).

During the visits, the status of both the old and the new receiving systems must be checked, and a check sheet (Fig. C-1) filled out for each system.

The heating system, and the general status of the buildings and the antenna tower must be checked. In case of problems with the buildings and the tower, the GC civil engineering must be notified.

The operation of the two systems must be monitored for a few minutes to make sure they operate as intended.

If the systems need new data tapes, change of tapes is required.

If any operational errors are found, immediately call AFGL:

BLDG. #1910 Rev. 26 Mar 1988

DD/MM/YY

Technician:__________ Date:______________Time:____________UT

KENNEDY DATA RECORDER: Status lights: (X) =)n; ( ) = Off.

( )STAT ( )PROT ( )LLP ( )TRK1 ( )TRK2 ( )TRK3 ( )TRK4 ( )LEOT

( )READY ( )MOTION

______ If TRK3 or TRK4 light is on CHANGE TAPE.

______ Does tape load properly?

E.A. CHART RECORDER:

______ Does six frequency pattern repeat every two hours?

Correct Da.e and Time marked on chart.

PRINTER:

______ Is paper free to move, and is there adequate supply of paper?

______ Are printouts of noise, calibration and tape use present?

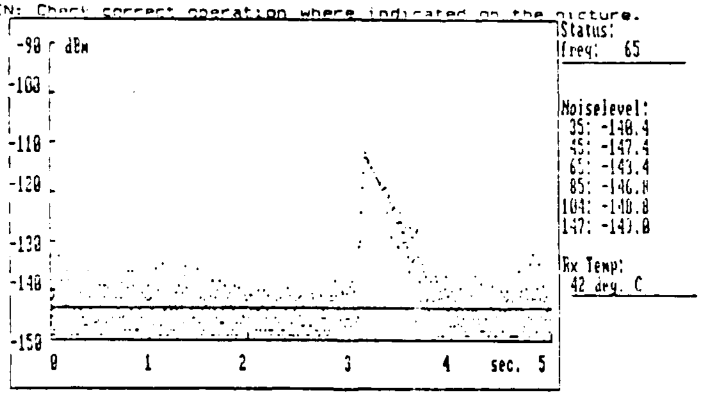
______ Are there any error messages? If so call AFG.

MODEM: Status lights" (X) = On; ( ) = Off.

( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )

AA TR MR

SCREEN: Check correct operation where indicated on the picture.



Trail record last entry: 171055___Tape left:100%_____

trailflag 2

current time: 26/03/1988 17:10:59__count = 2

!!!NOTE!!! If any readings are outside limits, incorrect, or no meteor trails are present on the E.A. RECORDER or the COMPUTER SCREEN, Call AFGL IMMEDIATELY: AUTOVON 47-3595, 478-2525.

FIGURE C-1. THULE CHECKLIST: NEW METEOR SCATTER RECEIVING SYSTEM

****
* Ionospheric Interaction Branch *
* Ionospheric Physics Division *
* Air Force Geophysics Laboratory *
* Hanscom AFB, MA 01731 *
* *
* Telephones: Autovon 478 - 2525 or *
* 478 - 3595 or *
* 478 - 2109 *
* *
* MSGT Dave Mura *
* Ask for: SMSgt Tony Coriaty or *
* Mr Al Bailey or *
* Sgt Curt Curtis or *
* Mr John Rasmussen *
****

The telephone at number 478 - 2525 has a phone answering machine attached, so that you can call outside office hours. When you get the ready tone from the recorder please state:

****
* Your NAME *
* The time of the call DAY, HOUR and MONTH. *
* Briefly describe the problem. *
* *
****

It is very important that all the above-mentioned information be given. It will enable us to separate old and new messages on the answering machine. We will call you back as soon as possible. Please be a little patient with us. Even if you do not immediately receive a call from us, we may still work at the problem, or we may temporarily be out of the office. Also, if you do not get hold of us right away, please call again until you get your message through to one of us.

3. REQUIRED WEEKLY MAINTENANCE

Each week, filled data tapes, charts, computer printouts and check sheets must be mailed registered to:

```
***********************************
*     AFGL/LID                    *
*     Attn:  SMSgt T. Coriaty     *
*     Hanscom AFB, MA  01731      *
***********************************
```

4. MASTER SCHEDULE FOR THE METEOR SCATTER TRANSMISSIONS

The meteor scatter transmitter at Sondrestrom AB transmits a carrier FM modulated with a 400 Hz tone on the six different frequencies used. The schedule of transmission repeats every two hours, beginning each even hour UT, i.e. 0000 UT, 0200 UT, 0400 UT, etc.

Short intervals between the transmissions are used by the receiving system to measure the background noise levels and to perform a self calibration.

The schedule within a two hour period (120 min.) is:

from min:	to min:	do:
000	000:59	For noise measurement
001	010:59	Transmit 45 MHz
011	011:59	For noise measurement
012	026:59	Transmit 85 MHz
027	027:59	For noise measurement
028	040:59	Transmit 35 MHz
041	041:59	For noise measurement
042	061:59	Transmit 104 MHz
062	062:59	For noise measurement
063	077:59	Transmit 65 MHz
078	078:59	For noise measurement
079	098:59	Transmit 147 MHz
099	100:59	For self calibration
101	101:59	For noise measurement
102	119:59	Free time. No transmissions

The new receiving system follows this schedule exactly. The old receiving system follows a schedule which is compatible:

000	025	Receive at 45 MHz
030	055	Receive at 104 MHz
060	085	Receive at 65 MHz

Thus the old system will catch the transmissions at 45, 65, and 104 MHz as available. In addition, a self calibration of the old system takes place every day at 1227 UT.

5. OPERATING INSTRUCTIONS FOR THE NEW RECEIVING SYSTEM

5.1 OPERATIONAL CHECK OUT OF THE NEW SYSTEM

An operational check out of the new receiving system contains the following points:

DATA TAPE USAGE:

If the TRK3 or TRK4 light is lit on the tape deck, then change the data tape as described in paragraph 5.3.

CHART RECORDER:

The chart recorder displays the amplitude of the horizontal channel of the receiver in dBm. The values from -150 dBm to -100 dBm with 1 dBm per division are plotted. Look at the last days recording on the chart, and compare with the example on the wall. Is the expected two hour sequence of noise and trail recording present? Is the time correct? Mark the chart with the time according to the time on the computer screen.

If any problems, note the differences on the check sheet and call AFGL.

Is it time to cut the chart and mail it to AFGL?

PRINTER:

Look at the printout for the last two hours. Are the printouts of noise measurements, calibrations and number of trails present. The format should look like the example on the wall. The noise temperature is printed in degrees Kelvin. The reasonable noise range should be from a few hundred to a few thousand degrees.

Is the paper supply functioning properly? Does the paper output go onto the floor in FRONT of the printer?

MODEM:

The lamps marked AA, TR, and MR on the front of the modem box must be lit.

COMPUTER SCREEN:

The computer screen may show three different displays. The most common is the display shown on the check sheet. Two other displays will occur during noise measurement and self calibrations. The noise measurement and calibration only lasts one minute each. Therefore, if you start a operational check during a noise measurement or a calibration, please wait for the display shown on the check sheet to reappear on the screen. This should occur within one minute.

CHECK THE FOLLOWING ON THE SCREEN:

Is the current time and date displayed correct?

(The computer clock should be accurate enough to run for a year, and the time is not supposed to be corrected.)

Does the time advance in five second jumps?

Check the status:

Compare the frequency selected with the schedule on the wall. Is the correct frequency selected?

Is the receiver temperature (Rx Temp) in the interval +30 to +46 degrees C.?

Is the tape status message: 'Tape lext XX%'? Change the tape if the reading is 30% or less.

Watch the graph. The received signals and noise must move across the screen. Most will be noise, shown as scattered dots, but meteor trails will also show up. The noise power for each frequency should be within -130 to -150 dBm.

The reception of a meteor trail is heard as a 400 Hz tone in the speaker. The trail will show up on the graph as a signal above the noise approximately five seconds after the tone.

Does the Trailflag change from 0 to 2, when a trail is received?

Does the tape move (tape motion light blinks), as the trail is stored?

Does the time of storage show up on the line just below the graph?

This concludes the operational check out of the new receiver system.

If you note any abnormalities, call AFGL immediately.

5.2 CHANGE OF DATA TAPE ON THE NEW SYSTEM

PLEASE NOTE!!

****

The data tapes have four data tracks which will be filled in succession. When the tape is loaded, data storage on the tape starts at the beginning of track one. When track one is filled, recording continues at the beginning of track two, etc.

The data tape must be changed when recording takes place on track three or track four. You must not wait to change the tape until recording takes place at the end of track four. Such practice could result in a loss of data as the tapes run out of space. It is more important for us not to lose data than to fully use the tapes. The cost of the tapes is a minor concern compared to the cost of the measurement program.

****

To change tape:

Watch the 'MOTION' light on the front of the tape deck.

If the light is off, and the tape does not move, you can safely pull the tape out of the deck.

The message: 'Tape not on-line' will appear on the computer monitor when the computer tries to write a trail on the tape.

Complete the tape label with the time and date when the tape was removed. Prepare an unused tape with a label as shown below. Mount the tape in the tape deck.

Watch the TRK1, and READY lights come on. Watch the computer monitor for the message: 'Tape left 100%', which will occur when the computer writes the first trail on the new tape. Watch the system catch a meteor trail, and the tape move, as the trail is stored.

This concludes the change of data tape on the new receiving system.

If any errors or abnormal operating conditions are noted, call AFGL immediately.

Example of tape label for the new receiving system:

```
****************************************
*    Bldg. 1910 Thule.  New system.    *
*    Start:  26 Mar 1988    0832 UT    *
*    Stop:  27 Mar 1988    1021 UT     *
****************************************
```

5.3 START UP OF THE NEW RECEIVING SYSTEM

The new receiving system has a battery backed power supply which can keep the system operating through a 30 minute power failure. If longer power failures occur, the system will eventually shut down.

The system automatically restarts with a restoration of power after a power failure. The system may need to be manually restarted if the computer hangs up, or if the spare system is going to be used. The start up procedure is simple:

Turn on the mains switches:

On the back of the computer
On the front of the monitor
On the front of the tape deck
On the right side of the printer
On the front of the modem

Mount a new tape in the tape deck. Watch the tape being loaded, and the TRK1, and READY lamps light up on the tape deck.

Simultaneously press the three keys: CTRL, ALT, and DEL.

The system will now start up, and resume normal operation. Proceed to perform an operational check of the system.

During the start up procedure, a request to enter the serial number of the receiver in use will appear on the screen. This request should not be answered except when a change of receiver to the spare unit is performed. A change of receiver is described in Section 5.6.

5.4 OPERATION OF THE REMOTE TERMINAL

The remote terminal is connected to a telephone modem and a telephone line in Building 1971. The terminal is ready, when the two rightmost lights on the modem, marked TR and MR light up.

To use the terminal:

Switch on the power to the modem on the rear of the modem box.

Key in: ATPD3133'RETURN'

The terminal will now call the receiving system computer, which is connected to extension 3133 in Building 1910.

When the connection is established three messages on the status of the receiver can be displayed:

Message 1:

Key in: $01

The response can be: RECEIVING AT --- MHz.

Message 2:

Key in: #02

The response will be: TAPE SPACE LEFT: ---% if the tape space left is in the interval 100% to 30%.

If less than 30% of the tape space remains the message will be: TAPE FULL, CHANGE TAPE. If the tape is full, please change tape immediately.

Message 3:

Key in: $03

The response will be the status of the tape:

TAPE ON LINE
TAPE OFF LINE
TAPE WRITE PROTECTED
TAPE ERROR

The last three messages indicate operational errors. Please change the tape. If a change of tape does not result in normal operation, call AFGL.

To hang up:

Switch off the modem power on the rear of the modem box.

5.5 CHANGE TO THE SPARE COMPUTER SYSTEM

If a computer failure should occur, please call AFGL immediately. It may be necessary to switch to the spare computer system to resume operation. AFGL will direct you to switch to the spare system.

To switch computer systems:

Refer to Fig. C-2 and Fig. C-3 for system hardware configuration and cable wiring information.

Remove the data cable which connects the receiver interface (the blue box on the table) with the computer. This is the colored, flat cable.

Remove the 110 VAC mains cable to the receiver interface from the outlet in the computer rack.

Connect the 110 VAC mains cable to the receiver interface in a unused outlet in the spare computer rack.

Connect the data cable from the receiver interface to the back of the spare computer.

Modem cable and modem power must also be changed.

Turn on the spare computer system:

On the back of the computer
On the computer monitor
On the front of the tape deck
On the right side of the printer
On the back of the modem

Mount a unused, properly labeled tape in the tape deck.

Watch the TRK1, and READY lights on the tape deck come on.

The spare system should now start up and begin to receive and store meteor trails on the tape.

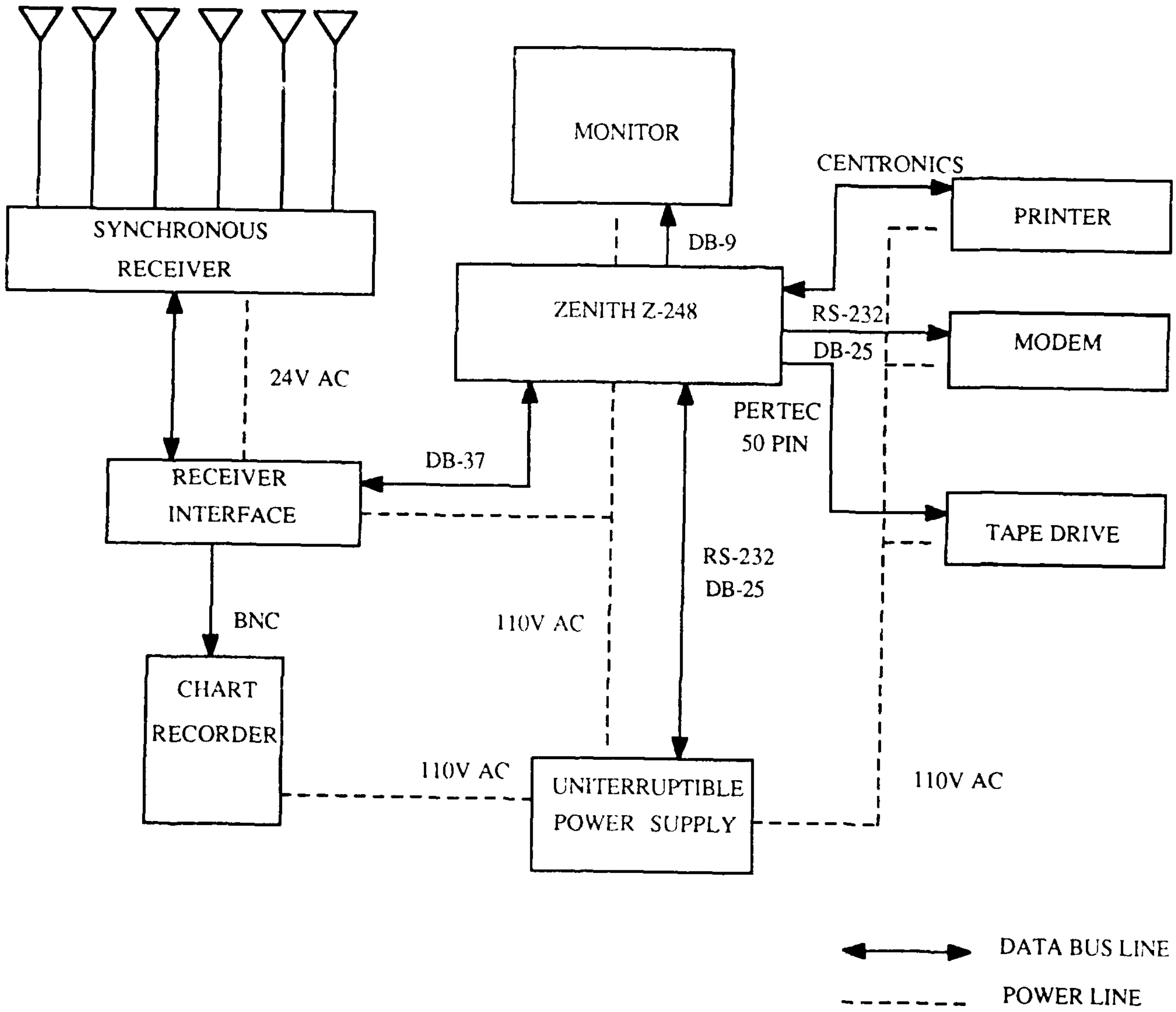


FIGURE C-2. RECEIVER SYSTEM HARDWARE BLOCK DIAGRAM

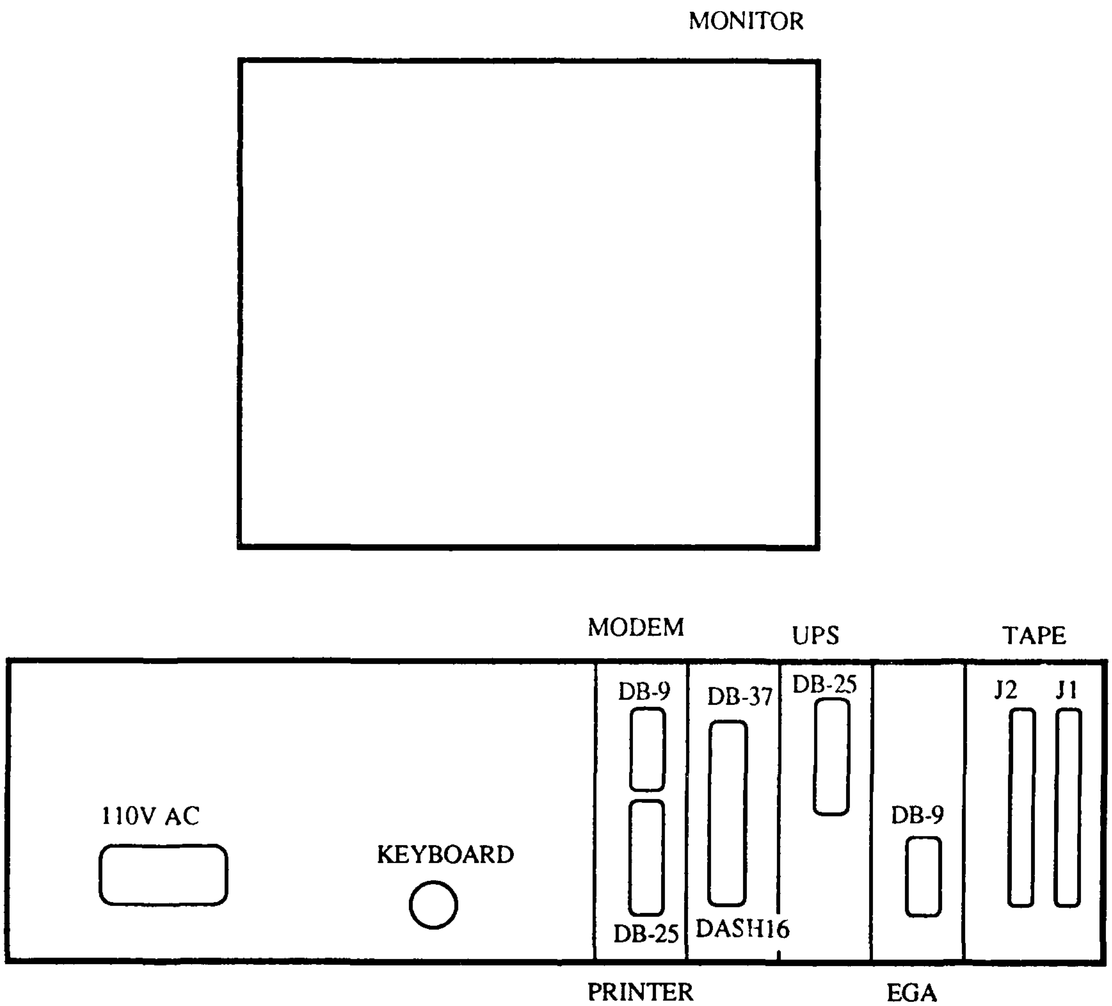


FIGURE C-3. REAR VIEW OF THE Z-248 COMPUTER

Perform an operational check out on the system, and fill out a check sheet.

If you note any problems, call AFGL immediately.

This concludes the switch to the spare computer system.

5.6 CHANGE OF THE RECEIVER

If you note operational abnormalities, which point to a receiver malfunction, please call AFGL immediately. A change of receiver may be needed. AFGL will direct you to change the receiver. A spare receiver and interface is found on the shelf in Building 1910.

To change receiver:

Refer to Fig. C-2 and Fig. C-3 for system hardware configuration and cable wiring information.

Switch off the mains on the receiver interface on the table in Building 1910.

Disconnect all cables on the receiver, which is mounted on the stair railing on the antenna tower, and remove the receiver.

Mount the spare receiver, and reconnect all cables. Make sure that all the antenna cables go to the right places. The cables are marked: i.e. 45H means 45 MHz Horizontal, and 85V means 85 MHz Vertical.

Note the serial number of the receiver. The number is found on the ElektronikCentralen label on the receiver lid.

Turn on the mains switch on the receiver interface. The receiver moise or a 400 Hz tone should now be heard in the speaker.

Change data tape on the computer system.

When a new receiver is installed, it is necessary to tell the computer the serial number of the new receiver.

Simultaneously press the keys CTRL, ALT, DEL, and watch the system start up. During the start up procedure, the computer will pause and place the question:

'Enter the serial number of the receiver: 1 - 5'

Please enter the serial number of the spare receiver, as one digit: i.e. 4.

Then the computer will prompt you the type of tape to be used. Please enter 1 for DC-300 or 2 for DC-600 tape.

The computer will now know that a different receiver and what type of tape have been installed.

During a normal start up, the questions of receiver serial number and tape should not be answered. After a few seconds wait, the computer will assume that the receiver in use is unchanged, and it will proceed through the start up and operation of the receiving system.

5.7 BASIC CALIBRATION OF THE RECEIVER

The basic calibration of the receiver involving injecting identifical signals with known amplitude level into the horizontal and vertical channels. The outputs at both channels are measured and the absolute gains and phase offset are calculated.

To calibrate receiver:

Refer to Fig. C-2 and Fig. C-3 for system hardware configuration and cable wiring information.

Disconnect meteor burst receiver from the Yagi antennas.

Use a power splitter and a signal generator to inject two identical to the horizontal and vertical channels of the selected frequency.

Execute software module (BASCAL) and follow instructions on the screen of the Z-248 computer.

The calibration results are output on the printer. The gains should be around -130 dBm while the phase offset could be from -360 to +360 degrees.